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**Jenkinson**

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(54) **HINGE ASSEMBLY FOR MOUNTING DOOR ON CABINET BELOW OPENING THEREOF**

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(51) **Int. Cl.**

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| *E05F 1/06* | (2006.01) |
| *F25D 23/02* | (2006.01) |

(52) **U.S. Cl.**

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USPC ..... 16/244, 248, 243, 309, 312, 374, 375, 16/303, 330, 338, 340, 235

See application file for complete search history.

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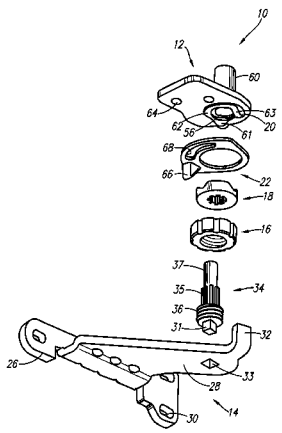
(57) **ABSTRACT**

A hinge assembly for mounting a door on a cabinet below an opening thereof is provided. The hinge assembly may include a pin defining an axis about which the door rotates, the pin being supported by a hinge plate and including a splined portion. Moreover, the hinge assembly may include a height adjuster including an inner circumference through which the pin extends and at least a portion that is rotatable about the pin. The hinge assembly additionally may include a first cam element including a cam surface and an inner circumference through which the pin extends, the inner circumference corresponding to the splined portion of the pin for mating therewith at a single position, the first cam element being vertically adjustable along the splined portion of the pin through rotation of the rotatable portion of the height adjuster about the pin.

**13 Claims, 5 Drawing Sheets**



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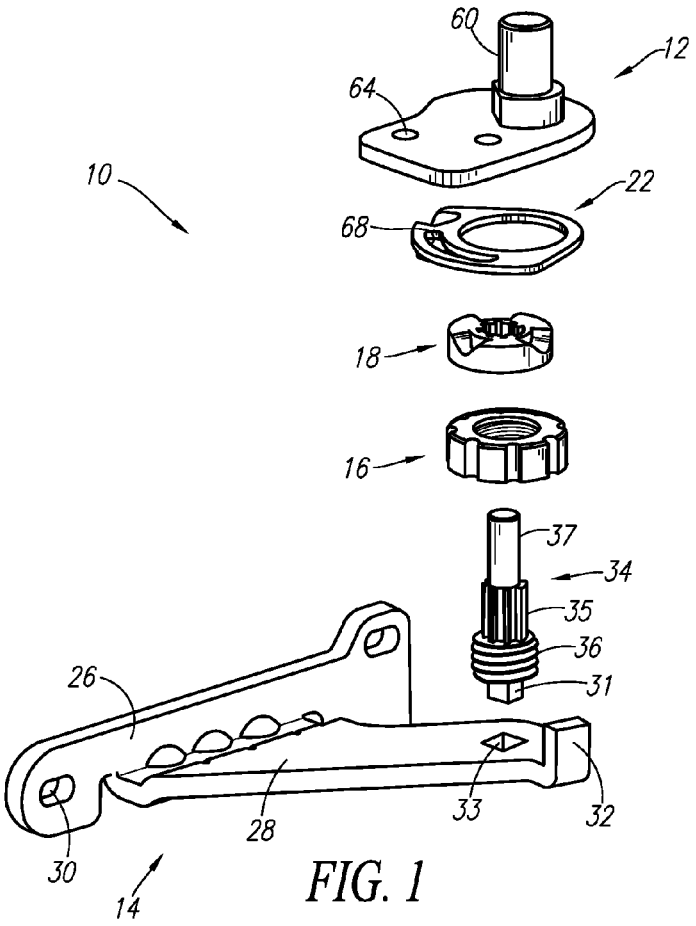
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FIG. 1

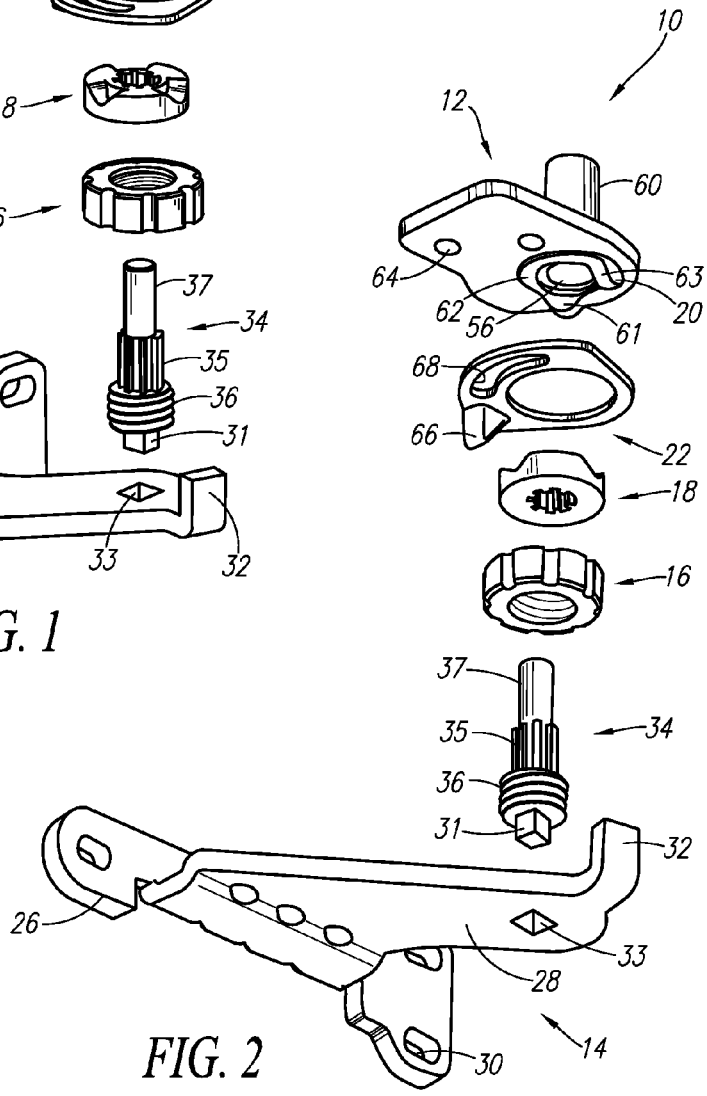
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FIG. 2

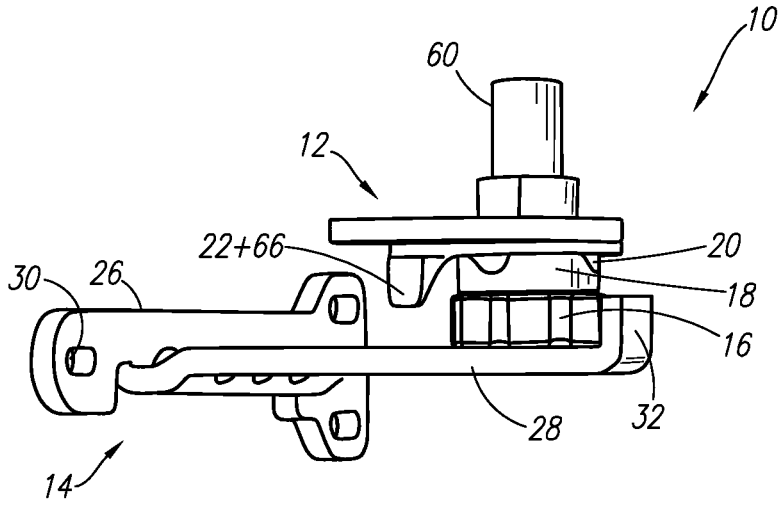



FIG. 3

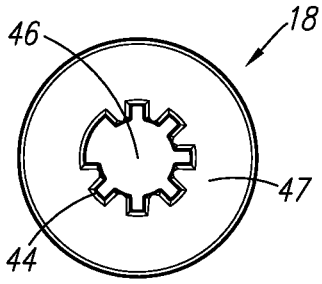



FIG. 4

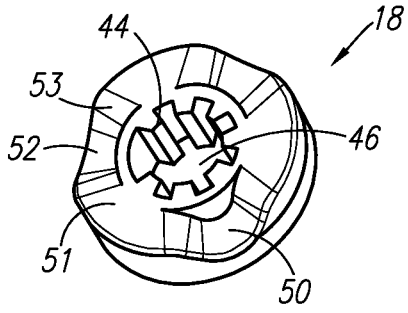
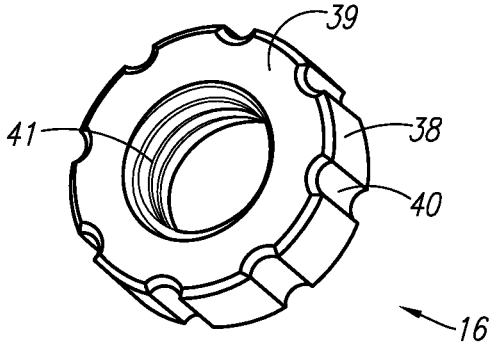



FIG. 5

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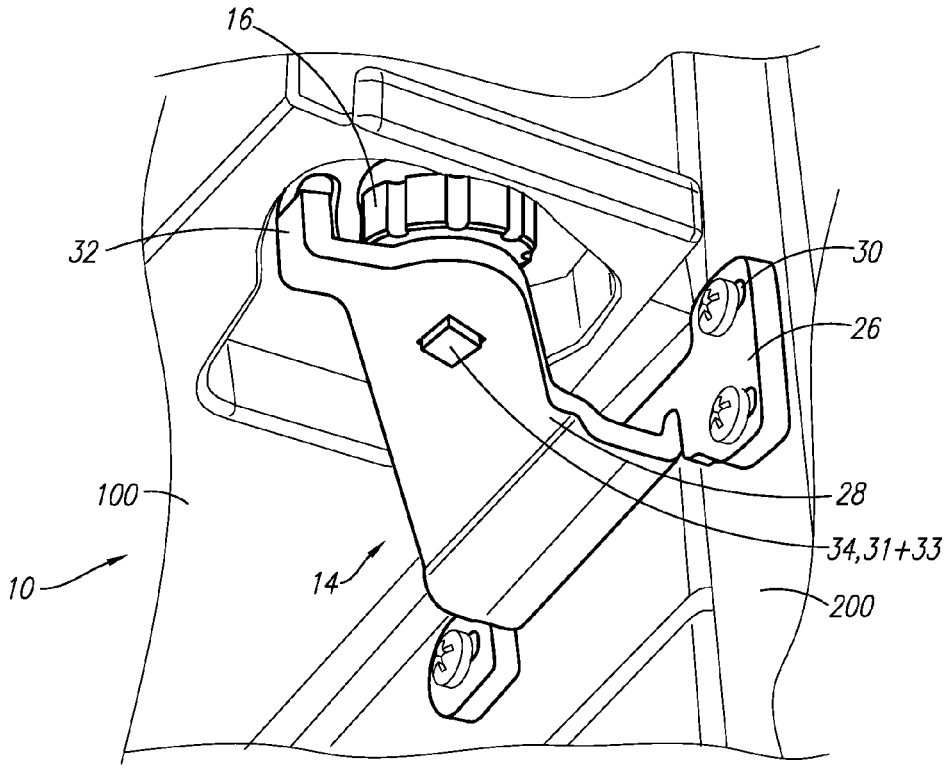
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FIG. 7

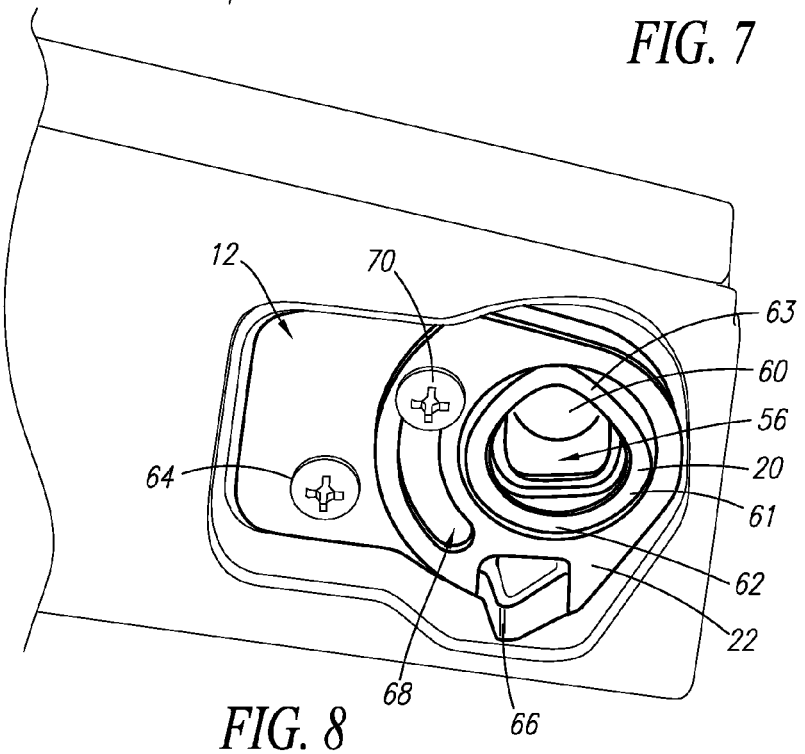
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FIG. 8

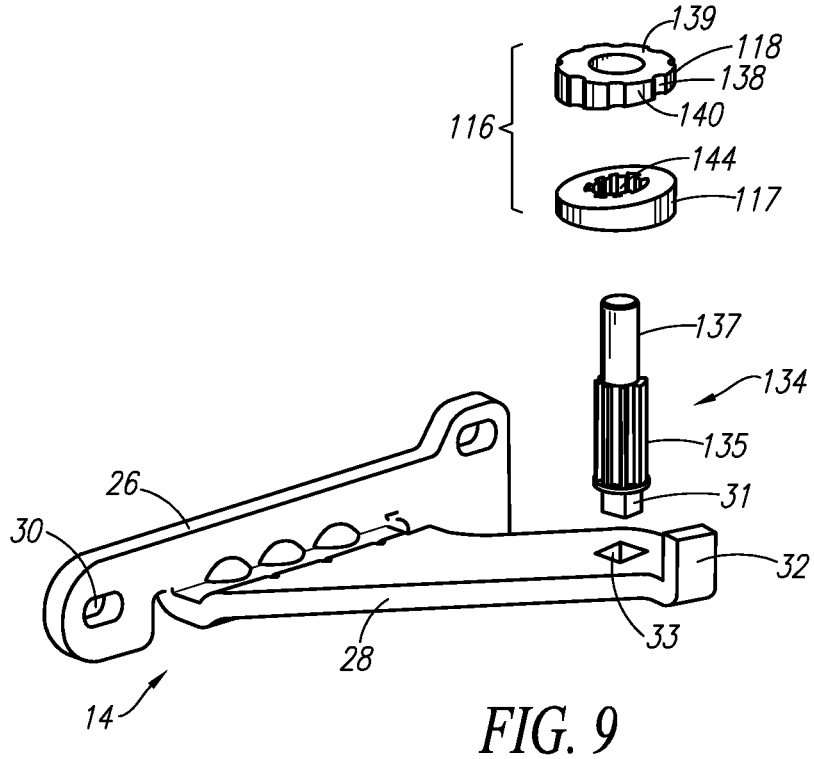
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FIG. 9

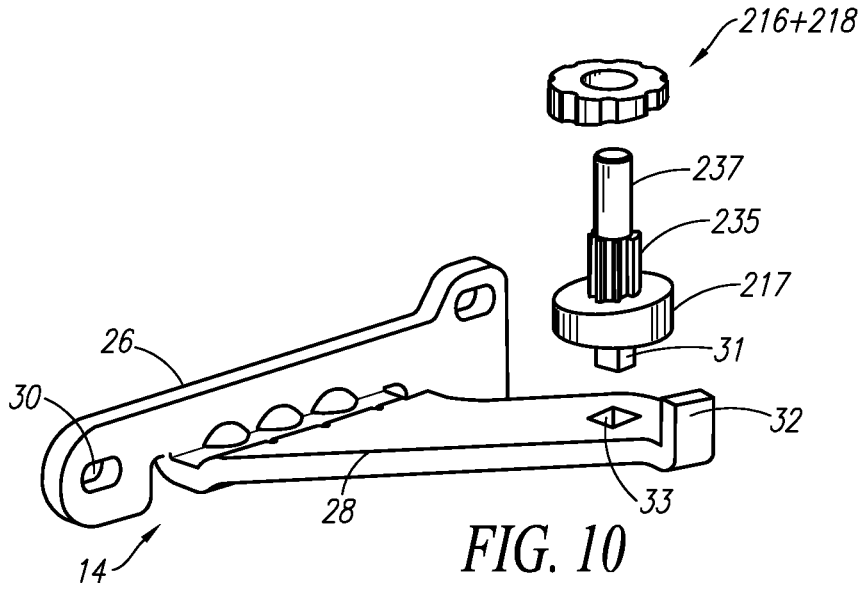
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FIG. 10

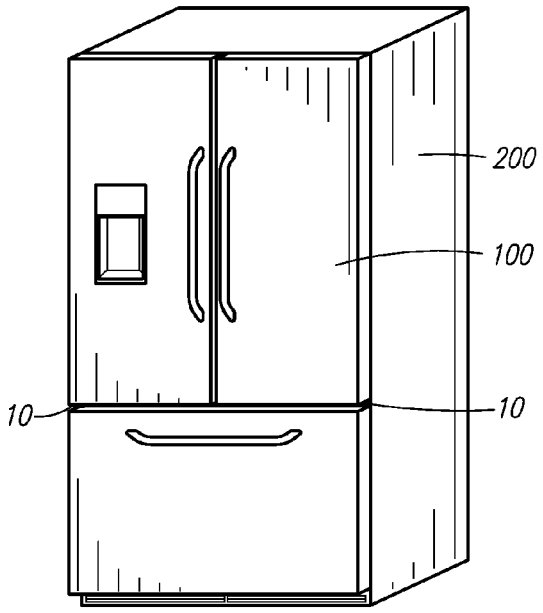


FIG. 11

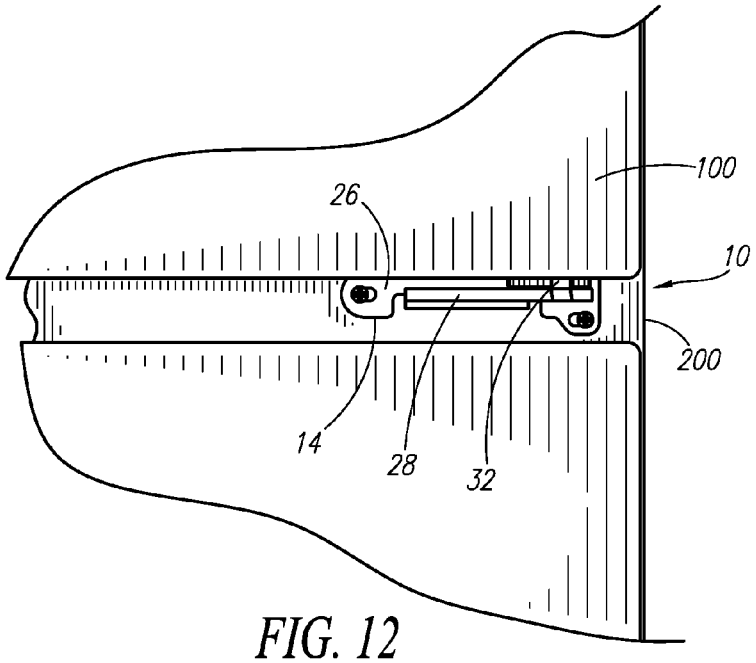


FIG. 12

# HINGE ASSEMBLY FOR MOUNTING DOOR ON CABINET BELOW OPENING THEREOF

## BACKGROUND

1. Field

The following description relates to a hinge assembly for mounting a door on a cabinet below an opening thereof.

2. Description of Related Art

A cabinet, such as a refrigerator, often includes multiple doors that provide access to a variety of compartments. The cabinet manufacturing process may produce variations in heights of side-by-side cabinet doors, thereby providing an appearance to a prospective consumer that is undesirable and unattractive. Sometimes such variations are not noticed until the product has left the manufacturing site, thereby requiring a service technician to be dispatched to fix the problem. Moreover, subsequent alignment of the cabinet doors involves experimentation that may prove to be time-consuming.

For example, one method of cabinet door alignment involves adding shims to one or more of the hinges of a door to adjust the height thereof. However, shims are usually not available to consumers. Further, special tools must be used to make adjustments using shims. In addition, doors must be removed from the cabinet in order to add the shims.

## SUMMARY

In one general aspect, there is provided a hinge assembly for mounting a door on a cabinet below an opening thereof. The hinge assembly may include a hinge plate supporting the door, the hinge plate being mounted on the cabinet below the opening thereof. The hinge assembly may further include a pin defining an axis about which the door rotates, the pin being supported by the hinge plate and including a splined portion. Moreover, the hinge assembly may include a height adjuster including an inner circumference through which the pin extends and at least a portion that is rotatable about the pin. The hinge assembly additionally may include a first cam element including a cam surface and an inner circumference through which the pin extends, the inner circumference corresponding to the splined portion of the pin for mating therewith at a single position, the first cam element being vertically adjustable along the splined portion of the pin through rotation of the rotatable portion of the height adjuster about the pin. The hinge assembly may further include a second cam element configured to rotate around the pin, the second cam element including an an inner circumference and a cam surface, the inner circumference having a diameter through which the pin extends that is greater than an outer diameter of the splined portion, the cam surface interacting with the cam surface of the first cam element upon rotation of the second cam element to control a position and an action of the door. The hinge assembly may additionally include a mounting plate onto which the second cam element is attached, the mounting plate being fastened to the door and including a projection fitting into a hole in the door, the pin being inserted into the projection, the projection being rotatable around the pin to facilitate rotation of the door about the axis. A vertical adjustment of the first cam element may serve to vertically adjust the second cam element and the mounting plate.

The height adjuster of the hinge assembly may further include a planar knurled surface facing away from the hinge plate. The first cam element may further include a knurled surface configured to mate with the planar knurled surface of the height adjuster to inhibit rotation of the rotatable portion of the height adjuster.

In addition, the hinge assembly may include a limiting plate surrounding the second cam element and the pin, the limiting plate including a tab. The hinge plate may include a stopper, the stopper being configured to inhibit the tab from passing a predetermined position to limit the rotation of the door to an angular range defined by the predetermined position at which the tab is inhibited from passing and a point at which the door meets the opening of the cabinet.

Further, the hinge assembly may include a fastener securing the limiting plate to the mounting plate. The limiting plate may further include a slot through which the fastener secures the limiting plate to the mounting plate. The predetermined position of the tab may be adjustable according to a position along the slot at which the fastener secures the limiting plate to the mounting plate.

Moreover, the hinge assembly may include a fastener securing the limiting plate to the door. The limiting plate may further include a slot through which the fastener secures the limiting plate to the door. The predetermined position of the tab may be adjustable according to a position along the slot at which the fastener secures the limiting plate to the door.

The cam surface of the first cam element may include elevated portions, depressed portions, and transitional portions connecting the elevated portions and the depressed portions.

The cam surface of the second cam element may include elevated portions, depressed portions, and transitioning portions connecting the elevated portions and the depressed portions. The elevated portions, the depressed portions, and the transitioning portions of the second cam element may interact with the elevated portions, the depressed portions, and the transitioning portions of the first cam element.

The elevated portions of the cam surface of the first cam element of the hinge assembly may divide a circumference of the first cam element into a plurality of arced zones between which the elevated portions of the cam surface of the second cam element are configured to move in order to control the position and the action of the door.

When an angular range defined by the position of the door and a point at which the door meets the opening of the cabinet is 0 to 20 degrees, the cam surface of the second cam element may interact with the cam surface of the first cam element to urge the door to the point at which the door meets the opening of the cabinet.

When an angular range defined by the position of the door and a point at which the door meets the opening of the cabinet is 125 degrees or greater, the cam surface of the second cam element may interact with the cam surface of the first cam element to maintain the angular range.

The hinge plate may include slots configured to allow mounting of the hinge plate on the cabinet below the opening thereof to be horizontally adjustable.

The hinge plate of the hinge assembly may include a rectangular hole. The pin may include a rectangular bush projecting from the pin and mating with the rectangular hole.

The pin may include a threaded portion and a cylindrical portion.

The inner circumference of the rotatable portion of the height adjuster may be threaded to interact with the threaded portion of the pin to enable the rotatable portion of the height adjuster to be rotatable about the pin.

The height adjuster may include a annular nut.

The cylindrical portion of the pin may be inserted into the projection. The projection may be cylindrical and rotatable

around the cylindrical portion of the pin to facilitate the rotation of the door about the axis.

The height adjuster may further include a first wedge and a second wedge, the first and second wedges including inner circumferences through which the pin extends, the first wedge being disposed at a position that is closer to the hinge plate than a position of the second wedge, the inner circumference of the first wedge being splined to mate with the splined portion of the pin to inhibit rotation of the first wedge about the pin, the inner circumference of the second wedge having a diameter that is greater than an outer diameter of the splined portion of the pin such that the second wedge is the rotatable portion of the height adjuster, the first and second wedges having variable thicknesses to form an annular nut with one combination of the thicknesses. Rotation of the second wedge may serve to form other combinations of the thicknesses of the first and second wedges and vertically adjust the first cam element along the splined portion of the pin, the other combinations having a height that is greater than a height of the one combination.

The second wedge may further include a planar knurled surface facing away from the first wedge. The first cam element may further include a knurled surface configured to mate with the planar knurled surface of the second wedge to inhibit rotation of the second wedge.

The pin may further include a first wedge positioned next to the hinge plate, the first wedge having a varied thickness. The height adjuster may further include a second wedge, the second wedge including an inner circumference through which the pin extends, the inner circumference of the second wedge having a diameter that is greater than an outer diameter of the splined portion such that the second wedge is the rotatable portion of the height adjuster, the second wedge having a variable thickness to form an annular nut with one combination of the thicknesses of the first and second wedges. Rotation of the second wedge may serve to form other combinations of the thicknesses of the first and second wedges and vertically adjust the first cam element along the splined portion of the pin, the other combinations having a height that is greater than a height of the one combination.

The second wedge further includes a planar knurled surface facing away from the first wedge. The first cam element may further include a knurled surface configured to mate with the planar knurled surface of the second wedge to inhibit rotation of the second wedge.

Other features and aspects may be apparent from the following detailed description, the drawings, and the claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded view illustrating an example of a hinge assembly for a door of an enclosed structure.

FIG. **2** is an exploded, top perspective view illustrating an example of the hinge assembly.

FIG. **3** is an assembled view illustrating an example of the hinge assembly.

FIG. **4** is a bottom view illustrating an example of a first cam element of the hinge assembly.

FIG. **5** is a top perspective view illustrating an example of a first cam element of the hinge assembly.

FIG. **6** is a top perspective view illustrating an example of a height adjuster of the hinge assembly.

FIG. **7** is a bottom perspective view illustrating an example of the hinge assembly.

FIG. **8** is a bottom view illustrating an example of a mounting plate and a second cam element of the hinge assembly

FIG. **9** is a partial exploded view illustrating another example of a hinge assembly for a door of an enclosed structure.

FIG. **10** is a partial exploded view illustrating yet another example of a hinge assembly for a door of an enclosed structure.

FIG. **11** is a perspective view illustrating an example of the enclosed structure on which the door is mounted using an example of the hinge assembly for the door of the enclosed structure.

FIG. **12** is a front view illustrating an example of the door mounted on the enclosed structure using an example of the hinge assembly for the door of the enclosed structure.

Throughout the drawings and the detailed description, unless otherwise described, the same drawing reference numerals will be understood to refer to the same elements, features, and structures. The relative size and depiction of these elements may be exaggerated for clarity, illustration, and convenience.

## DETAILED DESCRIPTION

Examples incorporating one or more aspects of the present invention are described and illustrated in the drawings. These illustrated examples are not intended to be limiting. For example, one or more aspects of the present invention may be utilized in other embodiments and even other types of devices.

Examples of the present invention may be applicable to a variety of enclosed structures having an opening that is closed by pivoting doors, such as refrigerators, freezers, wine cellars, cabinets, closets, cupboards, and other similar structures known to those of ordinary skill in the art. However, examples of the present invention may also be part of a larger structure, such as a building for an opening thereof, such as a window or door. The enclosed structure may have one or more doors that pivot to open or close a compartment and are hinged by assemblies, such as examples of the present invention. In one example of the present invention, two out-swinging doors (i.e., side-by-side or French style doors) can be provided to reveal the compartments of the enclosed structure, such as in a refrigerator or freezer.

Referring to the examples illustrated in FIGS. **1-3**, **7**, **8**, **11**, and **12**, a hinge assembly **10** that is configured to adjust a height of doors **100** is shown as implemented on an enclosed structure **200**, such as a cabinet. Although it is not limited thereto, the enclosed structure **200** enclosed by the doors **100** may be in the form of a domestic refrigerator/freezer unit.

The hinge assembly **10** illustrated in the figures is adapted to be mounted on a right side, as viewed by a user, of the enclosed structure **200**. Thus, a hinge assembly **10** adapted to be mounted on a left side, as viewed by a user, of the enclosed structure **200** would substantially mirror the illustrated hinge assembly **10** in shape. A person of ordinary skill in the art will be able to make the accommodations necessary to construct a hinge assembly **10** adapted to be mounted on the left side based on the description below.

Referring to the examples illustrated in FIGS. **1-8** and **12**, the hinge assembly **10** may include various elements, such as any or all of a mounting plate **12**, a hinge plate **14**, a height adjuster **16**, a first cam element **18**, a second cam element **20**, a limiting plate **22**, and a pivot pin **34**.

The hinge plate **14** allows the hinge assembly **10** to be mounted near an opening of the enclosed structure **200** to support the door **100**. Referring to the examples illustrated in FIGS. **1-3**, **7**, and **12**, the hinge plate **14** may include a mounted portion **26** and a base portion **28**. The mounted

portion **26** of the hinge plate **14** may be oriented upright and elongate to extend across a surface of the enclosed structure **200** in a mounted state. The mounted portion **26** may include recesses or slots **30** that enable the hinge plate **14** to be removably or non-removably secured on an exterior of the enclosed structure **200** by way of fastening members, such as screws. The slots **30** may be horizontally elongate to promote fastening adjustability along the exterior of the enclosed structure **200**. However, other means known in the art for securing the hinge plate **14** to the enclosed structure **200**, such as gluing, nailing, or the like, may also be used.

The base portion **28** of the hinge plate **14** provides a surface on which other components of the hinge assembly **10** may be mounted. As shown in the examples illustrated in FIGS. **2** and **3**, the base portion **28** may include a stopper **32** that is configured to limit a rotation range of the door **100**, as will be described later. In this example, the base portion **28** is configured to extend laterally from a side of the enclosed structure **200**. Near a proximal end, the base portion **28** has a rectangular hole **33** that is configured to releasably engage a rectangular bush **31** of the pivot pin **34**.

The pivot pin **34** may include the rectangular bush **31**, a splined portion **35**, the threaded portion **36**, and a cylindrical portion **37** that is neither threaded nor splined. The rectangular bush **31** may project downward from the threaded portion **36** and can be inserted into the rectangular hole **33** of the base portion **28** to secure the pivot pin **34**. The pivot pin **34** may project vertically upward from a surface of the base portion **28** to define a rotational axis for the door **100**. The insertion of the rectangular bush **31** into the rectangular hole **33** can enable the pivot pin **34** to remain stationary throughout rotation of the door **100** about the rotation axis created by the pivot pin **34**.

The threaded portion **36** may be provided adjacent to the rectangular bush **31** on the pivot pin **34**. The threaded portion **36** may be disposed above the base portion **28** of the hinge plate **14** when the rectangular bush **31** is secured by the rectangular hole **33** of the base portion **28**. The threaded portion **36** may have threads around a circumference of the pivot pin **34** to accommodate internal threads **41** of the height adjuster **16**.

Referring to the examples illustrated in FIGS. **1-3**, **6**, and **7**, the height adjuster **16** may be an annular element having peripherally provided notches **40** arranged in various patterns, including, but not limited to, random patterns. The height adjuster **16** may also include coarse knurled surfaces **38** between the notches **40**. The notches **40** and the knurled surfaces **38** can enable an operator to grasp the height adjuster **16** manually or with a tool, such as a wrench. The internal threads **41** and accommodations provided to the internal threads **41** by the threaded portion **36** of the pivot pin **34** can enable an operator that has grasped the height adjuster **16** to move the height adjuster **16** up or down relative to the threaded portion **36** of the pivot pin **34** by rotating the height adjuster **16** around the pivot pin **34** along the threaded portion **36**.

In addition, as will be described further with respect to the first cam element **18**, the height adjuster **16** may include, on a surface of the height adjuster **16** that faces away from the hinge plate **14**, at least one planar knurled surface **39** that is less coarse than the knurled surfaces **38**. In an example, the height adjuster **16** may be formed with two separate planar knurled surfaces **39** to ease assembly of the hinge assembly **10** and to moot any concern by an operator regarding the orientation of the height adjuster **16**.

The splined portion **35** of the pivot pin **34** may be provided adjacent to the threaded portion **36** on the pivot pin **34** and separated from the rectangular bush **31** of the pivot pin **34** by the threaded portion **36**. The splined portion **35** may include splines that are configured to mate with internal splines **44** formed in an inner circumferential portion of the first cam element **18**. The splines of the splined portion **35** may be scattered circumferentially around the pivot pin **34**. The splines may project vertically from the threaded portion **36** along the pivot pin **34**. The mating of the internal splines **44** of the first cam element **18** with the splines of the splined portion **35** can serve to inhibit rotation of the first cam element **18** during rotation of the door **100** while allowing vertical adjustment of the first cam element **18** along the splines of the splined portion **35** of the pivot pin **34**, the vertical adjustment corresponding to a position attained by the height adjuster **16** through rotation about the pivot pin **34**.

The splined portion **35** of the pivot pin **34** and the internal splines **44** of the first cam element **18** may be shaped such that the first cam element **18** will fit on the pivot pin **34** in a single position in order to inhibit any possible assembly variation. In an example, the splines of the splined portion **35** may be evenly spaced around the pivot pin **34**, and the internal splines **44** of the first cam element **18** may be formed to mate therewith. However, the placement and the shape of the splines on the splined portion **35** are not limited thereto, as the placement and the shape of the splines on the splined portion **35** around the pivot pin **34** may vary and/or be random, and the internal splines **44** of the first cam element **18** may be formed to mate therewith.

In addition, the first cam element **18** may include a knurled surface **47** that is configured to face the hinge plate **14** when the internal splines **44** of the first cam element **18** are mated with the splines of the splined portion **35** of the pivot pin **34**. When the first cam element **18** is positioned on the splined portion **35** of the pivot pin **34** above the height adjuster **16**, the knurled surface **47** of the first cam element **18** can mate with the planar knurled surface **39** of the height adjuster **16** to inhibit rotation of the height adjuster **16** around the pivot pin **34** along the threaded portion **36** that may otherwise be caused by repeated usage or downward force of the door **100**.

For example, when an operator is not grasping the height adjuster **16** to move the height adjuster **16** up or down relative to the threaded portion **36** of the pivot pin **34** by rotating the height adjuster **16** around the pivot pin **34** along the threaded portion **36**, the mating of the knurled surface **47** of the first cam element **18** with the planar knurled surface **39** of the height adjuster **16** can serve to inhibit movement of the height adjuster **16** along the threaded portion **36** of the pivot pin **34**. In another example, when an operator is grasping the height adjuster **16** to move the height adjuster **16** up or down relative to the threaded portion **36** of the pivot pin **34** by rotating the height adjuster **16** around the pivot pin **34** along the threaded portion **36**, the first cam element **16** can be moved axially along the pivot pin **34** by the rotation of the height adjuster **16**.

As a result, the mating of the knurled surface **47** of the first cam element **18** with the planar knurled surface **39** of the height adjuster **16** facilitate a desired height of items that are placed above the height adjuster **16** and surrounding at least a portion of the pivot pin **34**, including, but not limited to, the door **100**. Moreover, the mating of the knurled surface **47** of the first cam element **18** with the planar knurled surface **39** of the height adjuster **16** can inhibit rotation of the height adjuster **16** around the pivot pin **34** along the threaded portion **36** such that a likelihood of the height adjuster **16** wiggling and/or shifting to a position other than a desired position along the threaded portion **36** as a result of repeated usage or downward force of the door **100** may be reduced.

Further, the first cam element **18** can be configured to control movement of the door **100** around an axis of the pivot pin **34**. For example, the first cam element **18** may have a cam surface **50** on a side of the first cam element that is configured to face away from the hinge plate **14** and is opposite to that of the knurled surface **47**. The cam surface **50** may include elevated portions **51**, depressed portions **52**, and transitioning portions **53** serving to connect the elevated portions **51** and the depressed portions **52**. In an example, the cam surface **50** may include three elevated portions **51** and three depressed portions **52** respectively connected by three transitioning portions **53**.

At the edge of the internal splines **44** that are formed in the inner circumferential portion of the first cam element **18**, a central aperture or bore **46** may be formed through a center portion of the first cam element **18**. The bore **46** can allow the cylindrical portion **37** of the pivot pin **34** to extend there through without constraint.

Referring to the examples illustrated in FIGS. **2**, **3**, and **8**, the first cam element **18** can be configured to interact with the second cam element **20** of the mounting plate **12**. In this example, the second cam element **20** may be integrated into the mounting plate **12**. However, the second cam element **20** is not limited thereto. For example, the second cam element **20** and the mounting plate **12** may be separate components that are attached together by fastening through welding, glue, or other fastening methods known to one having ordinary skill in the art.

The mounting plate **12** includes recesses or holes **64** configured to enable the securing of the mounting plate **12** to the door **100** via securing structures, such as screws. In addition, the mounting plate **12** may have a cylindrical hole **56** that is provided within an inner circumferential surface of the second cam element **20** and a corresponding portion of the mounting plate **12**. A projection **60** of the hole **56** may be provided in the mounting plate **12** to project from the hole **56** to a side of the mounting plate **12** that is opposite a side of the mounting plate **12** on which the second cam element **20** can be disposed. The cylindrical portion **37** of the pivot pin **34** can be inserted through the hole **56** and the projection **60** of the hole **56** such that the mounting plate **12** and the second cam element **20** are allowed to rotate with movement of the door **100** around the pivot pin **34**.

Around the hole **56**, the second cam element **20** may include a surface having elevated portions **61**, depressed portions **62**, and transitioning portions **63** serving to connect the elevated portions **61** and the depressed portions **62**. The elevated portions **61**, depressed portions **62**, and transitioning portions **63** of the second cam element may be configured to interact with the depressed portions **52**, the elevated portions **51**, and the transitioning portions **53** of the first cam element **18**. The interaction between the depressed portions **52**, the elevated portions **51**, and the transitioning portions **53** of the first cam element **18** and the elevated portions **61**, depressed portions **62**, and transitioning portions **63** of the second cam element **20** can cause the second cam element **20** to be moved up and down as the second cam element **20** rotates around the pivot pin **34** according to the depressed portions **52**, the elevated portions **51**, and the transitioning portions **53** of first cam element **18**.

In addition, the interaction between the depressed portions **52**, the elevated portions **51**, and the transitioning portions **53** of the first cam element **18** and the elevated portions **61**, depressed portions **62**, and transitioning portions **63** of the second cam element **20** may cause the door **100** to self-close or remain open depending on an angular position of the door **100**. In an example, the door **100** can be configured to automatically return to a closed position when the angular position of the door **100** is between 0 to 20 degrees relative to a front face of the enclosed structure **200**. In another example, the door **100** can be configured to automatically remain open when the angular position of the door **100** is 125 degrees or greater. In a further example, the door **100** can be configured to have more than two discrete angular positions to which the door **100** is biased.

Moreover, the angular positions at which the biased direction of the door **100** changes may vary. This variance can be made possible by the interaction between the elevated portions **61**, the depressed portions **62**, and the transitioning portions **63** of the second cam element **20** and the depressed portions **52**, the elevated portions **51**, and the transitioning portions **53** of the first cam element **18**. Referring to the examples illustrated in FIGS. **1**, **2**, **5**, and **8**, the elevated portions **51** of the first cam element **18** may divide up the circumference of the first cam element **18** into a number of arced zones between which the elevated portions **61** of the second cam element **20** may be configured to move. In other words, when a tip of one of the elevated portions **61** of the second cam element **20** crosses over an edge of one of the elevated portions **51** of the first cam element **18**, the weight of the door **100** may cause the tip of the one of the elevated portions **61** of the second cam element **20** to move along one of the transitioning portions **53** of the first cam element **18** from an elevation of the edge of the one of the elevated portions **51** of the first cam element **18** to an elevation of one of the depressed portions **52** of the first cam element **18**, thereby serving to bias the door **100** toward one of the discrete angular positions.

In an example, the mounting plate **12** may be configured to accommodate the limiting plate **22**. The limiting plate **22** may be secured at least partially around the second cam element **20** and the hole **56** of the mounting plate **12**. However, the limiting plate **22** is not limited thereto. In an example, the limiting plate **22** may be mounted directly on the door **100**. The limiting plate **22** may be substantially ring-shaped and include a hole configured to place the limiting plate **22** around the second cam element **20**.

In addition, the limiting plate **22** may include a tab **66**. The tab **66** can be configured to be caught by the stopper **32** on the base portion **28** of the hinge plate **14** to inhibit the door **100** from rotating to an angular position that is greater than a predetermined angular position. The tab **66** can be located at a distance from the rotational axis that is substantially equivalent to a distance from the rotational axis at which the stopper **32** is located.

The rotation range of the door **100** can be increased or decreased by adjusting a position of the limiting plate **22** with respect to the mounting plate **12** to control an angle at which the tab **66** is able to rotate prior to making contact with the stopper **32**. The limiting plate **22** includes a slot **68** through which a fastener **70**, such as a screw, is able to pass and secure the limiting plate **22** to the mounting plate **12**. The slot **68** is curved and allows the limiting plate **22** to be rotated with respect to the mounting plate **12** when the fastener **70** is removed.

FIG. **9** is an exploded view illustrating another example of a hinge assembly for a door of an enclosed structure. Referring to the example illustrated in FIG. **9**, a height adjuster **116** may be configured to interact with a pivot pin **134**. While the height adjuster **116** is not limited in its formation, the height adjuster **116** may have a shape of a nut that can be split into a first wedge **117** and a second wedge **118** having opposingly varied thicknesses. The shape of the nut may be formed when a thickest portion of the first wedge **117** mates with a thinnest

portion of the second wedge **118** and, simultaneously, a thinnest portion of the first wedge **117** mates with a thickest portion of the second wedge **118**. The height adjuster **116** is at its thinnest when the first wedge **117** and the second wedge **118** mate to form the nut and thickest when the thickest portion of the second wedge **118** is contacting the thickest portion of the first wedge **117**.

The first wedge **117** may be disposed at a position on the pivot pin **134** that is nearer to the hinge plate **14** than is the second wedge **118**. Further, the pivot pin **134** may include a splined portion **135** that ranges from the rectangular bush **31** to a cylindrical portion **137** that is not splined, thereby omitting any portion that is threaded. The first wedge **117** may have an inner circumferential portion having internal splines **144** configured to mate with the splined portion **135**, thereby serving to inhibit rotation of the first wedge **117**.

The second wedge **118** may have an inner portion with a diameter as great as an outer diameter of the splined portion **135** of the pivot pin **134**, thereby permitting the second wedge **118** to be rotatable around the pivot pin **134** while being in contact with the first wedge **117**. When the second wedge **118** is rotated around the pivot pin **134** while in contact with the first wedge **117**, the varying thicknesses of the first wedge **117** and the second wedge **118** can create a plurality of thicknesses for the height adjuster **116**. In other words, the varying thicknesses of the second wedge **118** may be rotated around the pivot pin **134** to rest on the first wedge **117** such that a combined height of the first wedge **117** and the second wedge **118** is greater than a height of the first wedge **117** and the second wedge **118** when the nut is formed. As a result, the height adjuster **116**, which is the combination of the first wedge **117** and the second wedge **118**, may serve to elevate the items which are designated to rest thereupon, i.e. the first cam element **18**.

In this example, similar to the height adjuster **16** featured in FIGS. **1-4** and **8**, the second wedge **118** of the height adjuster **116** may be an annular element having peripherally provided notches **140** arranged in various patterns, including, but not limited to, random patterns. The second wedge **118** of the height adjuster **116** may also include coarse knurled surfaces **138** between the notches **140**. The notches **140** and the knurled surfaces **138** can enable an operator to grasp the height adjuster **116** manually or with a tool, such as a wrench. The inner portion of the second wedge **118** with a diameter as great as an outer diameter of the splined portion **135** of the pivot pin **134** can enable an operator that has grasped the second wedge **118** to move the second wedge **118**, and, subsequently, the height adjuster **116**, up or down relative to the position of the first wedge **117** on which the second wedge **118** rests by rotating the second wedge **118** around the pivot pin **134** along the first wedge **117**.

In addition, the second wedge **118** may include, on a surface of the second wedge **118** that faces away from the hinge plate **14**, at least one planar knurled surface **139** that is less coarse than the knurled surfaces **138**. When the first cam element **18** is positioned on the splined portion **135** of the pivot pin **134** above the second wedge **118**, the knurled surface **47** of the first cam element **18** can mate with the planar knurled surface **139** of the second wedge **118** around the pivot pin **134** along the splined portion **135**. As with the height adjuster **16**, the mating of the knurled surface **47** of the first cam element **18** with the planar knurled surface **139** of the second wedge **118** can serve to inhibit movement of the second wedge **118** along the first wedge **117** and around the pivot pin **134** that may otherwise be caused by repeated usage or downward force of the door **100**.

As a result, the mating of the knurled surface **47** of the first cam element **18** with the planar knurled surface **139** of the second wedge **118** can facilitate a desired height of items that are placed above the second wedge **118** of the height adjuster **116** and surrounding at least a portion of the pivot pin **134**, including, but not limited to, the door **100**. Moreover, the mating of the knurled surface **47** of the first cam element **18** with the planar knurled surface **39** of the second wedge **118** of the height adjuster **116** can inhibit rotation of the second wedge **118** of the height adjuster **116** around the pivot pin **134** along the splined portion **135** such that a likelihood of the second wedge **118** of the height adjuster **116** wiggling and/or shifting to a position other than a desired position along the splined portion **135** as a result of repeated usage or downward force of the door **100** may be reduced.

FIG. **10** is an exploded view illustrating yet another example of a hinge assembly for a door of an enclosed structure. Referring to the example illustrated in FIG. **10**, a height adjuster **216** may be configured to interact with a pivot pin **234**. The first wedge **217** is similar to the first wedge **117** illustrated in FIG. **9**, except that the first wedge **217** may be fixed as a part of the pivot pin **234**. As a result, the pivot pin **34** may include the rectangular bush **31**, a first wedge **217**, a splined portion **235**, and a cylindrical portion **237** that is not splined. The second wedge **118** of the height adjuster **216** can interact with the splined portion **235** and the first wedge **217** of the pivot pin **234** in the same way that the second wedge **118** of the height adjuster **116** can interact with the splined portion **135** of the pivot pin **134** and the first wedge of the height adjuster **116**.

A number of examples have been described above. Nevertheless, it will be understood that various modifications may be made. For example, suitable results may be achieved if the described elements are combined in a different manner and/or replaced or supplemented by other elements or their equivalents. Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

**1**. A hinge assembly for mounting a door on a cabinet below an opening thereof, the hinge assembly comprising:

a hinge plate configured to mount the door to the cabinet, the hinge plate comprising a hole extending through the hinge plate;

a pin configured to define an axis about which the door rotates, the pin being supported by the hinge plate and comprising a bush, a splined portion, a threaded portion, and a cylindrical portion, the bush and the cylindrical portion being positioned at opposite ends of the pin, the threaded portion being positioned between the bush and the splined portion, the splined portion being positioned between the threaded portion and the cylindrical portion, the bush extending into the hole in the hinge plate, the bush engaging walls of the hole in the hinge plate to limit rotation of the pin;

a height adjuster comprising a threaded hole threaded onto the threaded portion of the pin and a knurled surface on a side of the height adjuster that faces away from the hinge plate;

a first cam element comprising a splined hole through which the splined portion of the pin extends, the splined hole engaging the splined portion of the pin to inhibit rotation of the first cam element, a cam surface facing away from the height adjuster, and a knurled surface engaging the knurled surface of the height adjuster to inhibit rotation of the height adjuster about the pin; and

a mounting plate comprising a second cam element interacting with the first cam element, the second cam ele-

ment comprising a cylindrical hole through which the cylindrical portion of the pin extends and a cam surface interacting with the cam surface of the first cam element, the cylindrical hole comprising an projection into which the cylindrical portion of the pin is positioned and a diameter that is greater than an outer

diameter of the splined portion of the pin, the engagement of the cam surfaces of the first and second cam elements being configured to control a position and an action of the door, the projection being rotatable about the pin and configured to fit into a hole in the door and rotate about the pin with the mounting plate,

wherein the height adjuster is configured to move vertically on the pin when rotated about the pin thereby adjusting the height of the door.

**2**. The hinge assembly of claim **1**, further comprising:

a limiting plate fastened to the mounting plate and surrounding the second cam element and the pin, the limiting plate being configured to rotate about the pin with the door, the limiting plate comprising a tab,

wherein the hinge plate comprises a stopper, the stopper being configured to inhibit the door from rotating past a predetermined position, and

wherein the predetermined position is defined by a position at which the tab contacts the stopper.

**3**. The hinge assembly of claim **1**, wherein the cam surface of the first cam element comprises elevated portions, depressed portions, and transitional portions connecting the elevated portions and the depressed portions.

**4**. The hinge assembly of claim **3**, wherein the cam surface of the second cam element comprises elevated portions, depressed portions, and transitioning portions connecting the elevated portions and the depressed portions, and

wherein the elevated portions, the depressed portions, and the transitioning portions of the second cam element interact with the elevated portions, the depressed portions, and the transitioning portions of the first cam element.

**5**. The hinge assembly of claim **4**, wherein the elevated portions of the cam surface of the first cam element divide a circumference of the cam surface of the first cam element into a plurality of arced zones between which the elevated portions of the cam surface of the second cam element are configured to move in order to control the position and the action of the door.

**6**. The hinge assembly of claim **1**, wherein, when an angular range defined by the position of the door and a point at which the door meets the opening of the cabinet is 0 to 20 degrees, the cam surface of the second cam element is configured to interact with the cam surface of the first cam element to urge the door to the point at which the door meets the opening of the cabinet.

**7**. The hinge assembly of claim **1**, wherein, when an angular range defined by the position of the door and a point at which the door meets the opening of the cabinet is 125 degrees or greater, the cam surface of the second cam element is configured to interact with the cam surface of the first cam element to maintain the angular range.

**8**. The hinge assembly of claim **1**, wherein the hinge plate comprises slots configured to allow mounting of the hinge plate on the cabinet below the opening thereof to be adjustable perpendicular to the axis.

**9**. The hinge assembly of claim **1**, wherein the hole of the hinge plate comprises a rectangular hole, and

wherein the bush of the pin comprises a rectangular bush projecting from the pin and mating with the rectangular hole.

**10**. The hinge assembly of claim **1**, wherein the projection is cylindrical to facilitate the rotation of the door about the axis.

**11**. The hinge assembly of claim **1**, wherein the splined portion of the pin comprises a plurality of splines extending from the threaded portion to the cylindrical portion of the pin, each of the splines protruding perpendicular to the axis away from a center of the pin and further from the center of the pin than an outer circumference of the cylindrical portion.

**12**. The hinge assembly of claim **1**, wherein the height adjuster further comprises a plurality of outer knurled surfaces positioned on an outer circumference of the height adjuster, and

wherein the outer knurled surfaces are configured to enable grabbing of the forcibly mated height adjuster to enable forcible rotation of the threaded hole about the pin.

**13**. The hinge assembly of claim **1**, wherein the protrusion is integrally formed in the mounting plate.

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